



New data on the Early Pleistocene large sized porcupine from Pirro Nord (Apricena, Apulia, Italy)

by

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with 5 text-figures and 1 table

Zusammenfassung

Aus Spaltenfüllungen frühpleistozänen Alters im Gebiet zwischen Apricena und Poggio Imperiale (Gargano, Apulia, Italien) werden Reste eines großen Stachelschweines beschrieben. Diese Wirbeltierfundstelle wurde in der Literatur unter dem Namen Pirro Nord bekannt und lieferte eine der reichsten Säugetierfaunen des frühen Pleistozäns in Italien. Die Stachelschwein-Reste von Pirro-Nord (Sammlungen Florenz und Rom) waren bereits in einer früheren Abhandlung *Hystrix refossa* zugeordnet worden. Das hier präsentierte neue Material trägt jedoch wesentlich zur Erweiterung des Wissens über die morphologische Variabilität dieses großen Nagers in dieser Fundstelle bei.

Schlüsselwörter: *Hystrix refossa* – Dentition – Postcranium – Pirro Nord – Frühes Pleistozän – Italien

Abstract

We report on new fossil remains of the large porcupine occurring in the Early Pleistocene faunal assemblage from fissure fillings in the area between Apricena and Poggio Imperiale (Gargano, Apulia, Italy). The vertebrate assemblage that yielded these *Hystrix* remains is known in the literature as Pirro Nord, and is one of the richest Early Pleistocene mammal assemblages from Italy. The porcupine remains from Pirro Nord (Florence and Rome collections) were object of a previous paper and were attributed to the species *Hystrix refossa*. The new specimens presented here enlarge the available sample and our knowledge about the variability of this large size rodent in the fossil assemblage.

Key words: *Hystrix refossa* – Dentition – Postcranium – Pirro Nord – Early Pleistocene – Italy

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Introduction

The fossiliferous localities known in the literature as Pirro Nord are situated near Apricena (Foggia province, Apulia, Southern Italy) on the north western slopes of the Gargano promontory. Early Pleistocene mammals from fissure fillings in the surroundings of Apricena have been collected since the late 1960s (Pieri collection, University of Bari) and reported

since the 1970s/1980s (FREUDENTHAL 1971, DE BEAUMONT 1979, DE GIULI & TORRE 1984, DE GIULI et al. 1987, ABBAZZI et al. 1996, GLIOZZI et al. 1997, DELFINO & BAILON 2000, DELFINO & ATZORI 2013, ARZARELLO et al. 2007, 2009, 2012, PAVIA et al. 2010, ROOK 2013). The Pleistocene fossil assemblage to which the materials here described belong, is very rich and consists of more than a hundred

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species of mammals, birds, reptiles, amphibians and rare fishes from the sandy-clayey fillings of a karst network which developed along the contact between a Mesozoic and a Pliocene succession (ABBAZZI et al. 1996). The late Villafranchian elements of the mammal fauna suggest an Early Pleistocene age, preceding the Jaramillo sub-magnetochrone as is also evidenced by the geomagnetic polarity of the sediments (NAPOLEONE et al. 2003, PAVIA et al. 2010). The Pirro Nord assemblages are characterized by the occurrence of the vole *Allophaiomys* ex gr. *ruffoi* (MASINI et al. 1998) a species that is indicative of the early Biharian (micro-) Mammal Age (SALA & MASINI 2007). The fossil assemblage is considered to be one of the youngest Italian faunas of the late Villafranchian, and Cava Pirro has been designated as the type locality of the Pirro Faunal Unit (GLIOZZI et al. 1997, TORRE et al. 2001, ROOK & MARTÍNEZ-NAVARRO 2010).

The porcupine remains from Pirro Nord, attributed to the species *Hystrix refossa* GERVAIS, 1852, and recovered in the early investigations in the area from the late '70s to the late '90s (Florence and Rome collections), have been described in a recent paper (ROOK & SARDELLA 2005).

New field activity in the Pirro Nord area has recently yielded a number of new fossil vertebrate remains along with some new porcupine material, housed in the collections of the University of Turin (PAVIA et al. 2012). This new sample is herein briefly described, enlarging the knowledge of the variability of *Hystrix* from Pirro Nord and supporting our previous conclusions (ROOK & SARDELLA 2005).

Neogene porcupines in Europe

The taxonomy of fossil Hystricidae is a matter of debate in the literature, especially due to the large intra-specific variability of the dental occlusal surfaces with the stage of attrition (it has been demonstrated that the occlusal surface morphologies are a function of the stage of attrition, VAN WEERS 1990).

In addition, the extreme conservatism of the hystricid dental pattern is responsible for some confusion in the taxonomy of fossil forms in this group. The use of wear categories proposed by VAN WEERS (1990, 1994) provides a useful methodology in order to compare the same wear stages thus avoiding the confusion derived from the ontogenetic morphological changes observed in *Hystrix* teeth (VAN WEERS 1985, 1994, 2005, VAN WEERS & MONTOYA 1996, VAN WEERS

& ZHENG SHAOHU 1998, VAN WEERS & ROOK 2003).

Occlusal length measurements of the cheek teeth are to be preferred in comparative analyses to that of occlusal breadth, because the latter is characterised by a very large amount of variation during the attrition of the tooth (occlusal breadth increases by wear in a disproportional way to other tooth dimensions, VAN WEERS 2005). Isolated first and second molars (both upper and lower) are impossible to distinguish, and are indicated as "M¹⁻²" or "M₁₋₂" (Table 1).

Fossil porcupines are relatively common in the European fossil record. The genus is represented by different species in Europe from the Late Miocene (Late Vallesian, MN 10 in the European mammal bio-chronology) onwards. The oldest representative of the genus is a small sized species allocated to *Hystrix parvae* (VAN WEERS & MONTOYA 1996). Larger species characterise the later Miocene (middle to late Turolian) and the early Pliocene (until the late Ruscinian). These late Miocene to Pliocene species have been historically lumped together into the species *Hystrix primigenia*, although, according to SEN (2001) and VAN WEERS & ROOK (2003), it is possible to distinguish a second species (*Hystrix depereti*) on the basis of its higher and on average larger cheek teeth. All the Miocene *Hystrix* species are relatively low crowned with a Crown Height / Occlusal Length ratio generally not much above 1.0. All the Late Pliocene – Pleistocene *Hystrix* species instead are characterised by a high degree of hypsodonty.

According to VAN WEERS (2005) "the most probable ancestor of the high-crowned Pleistocene HYSTRIX species may be *H. gansuensis* WANG & QIU 2002, from the Late Miocene in the Gansu province, China". An open question is, however, whether or not the general trend to hypsodonty in the family can be explained as a generalised trait, common to what is seen in many other herbivorous mammals during Mio-Pliocene time (JERNVALL & FORTELIUS 2002, FORTELIUS et al. 2003).

VAN WEERS (1994) provided a revision of the European Plio-Pleistocene record of *Hystrix refossa* GERVAIS, 1852, and clarified the taxonomic and nomenclatural status of this species. The species has been described from the fossil record under different names – *Hystrix major* GERVAIS, 1859, and *Hystrix etrusca* BOSCO, 1899 – that many authors have considered synonymous to *Hystrix refossa* (VIRET 1954, CHALINE 1972, AGUSTI et al. 1987, KOLIADIMOU &

KOUFOS 1991, MASINI & ROOK 1993, ROOK & KOTSAKIS 1994, ROOK & SARDELLA 2005, MONCHOT et al. 2012). The Plio-Pleistocene species *Hystrix refossa* differs from the typical porcupine from the Late Miocene and Pliocene of Europe (*H. primigenia* and *H. depereti*) by its stronger built postcranial skeleton and more hypsodont cheek teeth (VAN WEERS 1994, ROOK & SARDELLA 2005).

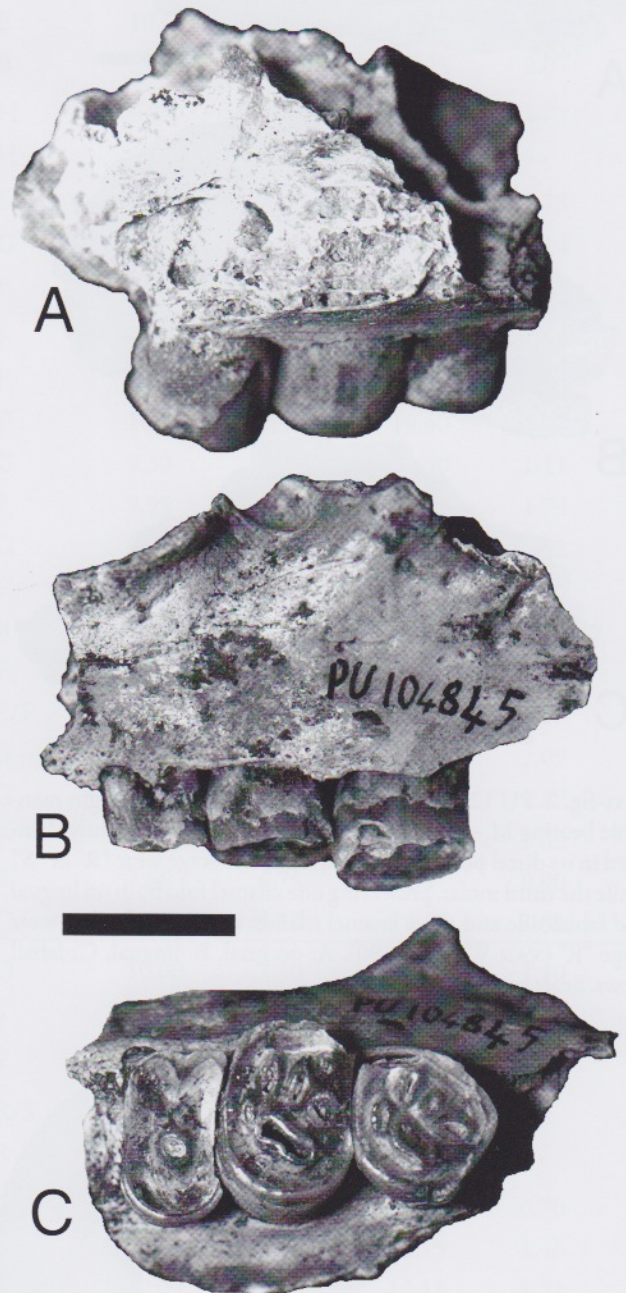
The Pleistocene record of Europe includes also a small sized species commonly referred to as *Hystrix vinogradovi* ARGYROPULO, 1941. Recently VAN WEER (2005) considered the latter a junior synonym of *Hystrix (Acanthion) brachyura* LINNAEUS, 1758. This small sized species of the Asiatic subgenus *Acanthion* was thus expanding its range into Europe during the Early Pleistocene to the Middle and Late Pleistocene (VAN WEERS 2005). The occurrence of *Hystrix vinogradovi* has been documented also in Italy in Middle to Late Pleistocene deposits (SALARI & SARDELLA 2009).

The new *Hystrix* material from Pirro Nord

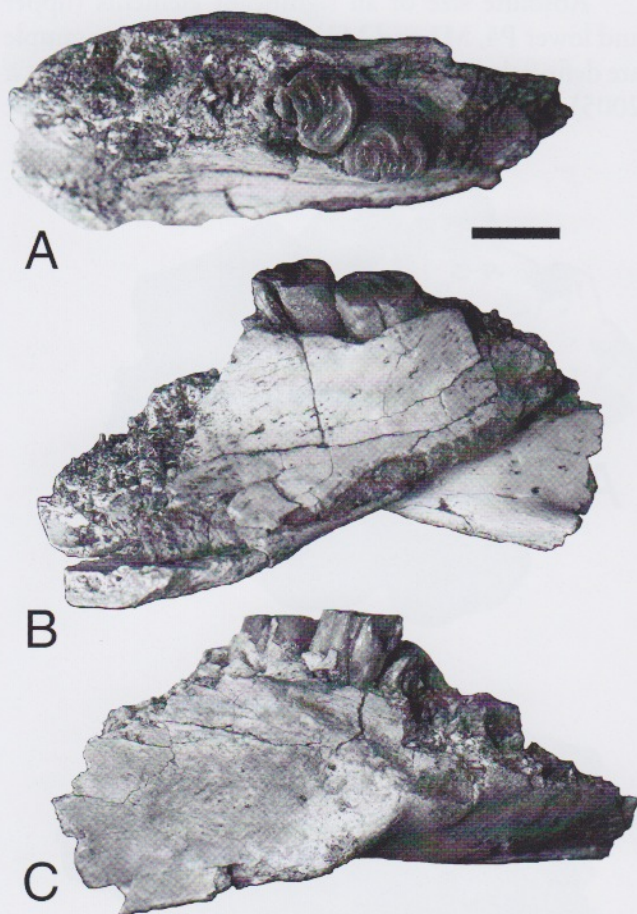
Fossils from Pirro Nord are stored in various collections, following the field work activities of different researchers. The porcupine sample, consisting of material housed in the Bari, Florence and Rome "La Sapienza" Universities, and that kept in the Leiden National Museum previously described (VAN WEERS 1994, ROOK & SARDELLA 2005), is now enlarged by the remains that have been collected in recent years by researcher from the University of Turin (PU – Palaeontological Museum, University of Turin). The sample available in the PU collections consists of about 60 specimens from six different karst cavities (Pirro 5, 7, 10, 11, 12 and 19). Craniodental remains are represented by very few maxillary bone (Text-fig. 1) and mandibular (Text-fig. 2) fragments, a few isolated incisor fragments and several isolated cheek teeth (Text-figs 3, 4, Table 1). A large part of this new sample consists of elements of the postcranium: humerus, radius, ulna, femur (Text-fig. 5), tibia, ischium, astragalus, metapodials, phalanges and vertebrae. All the specimens are relatively well preserved.

Table 1 provides the measurements of the PU sample and the ratio Crown Height / Occlusal Length (CH/L). The tooth wear stages are classified according the wear categorization proposed by VAN WEERS (1990), and range from A (unworn) to H (deeply worn) for upper teeth and O (unworn) to T (deeply worn) for lower teeth.

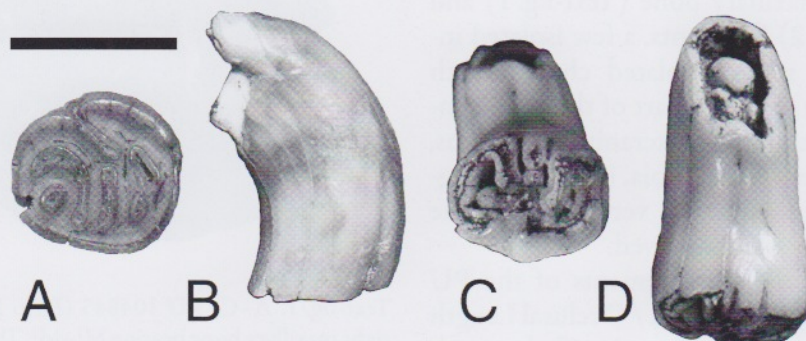
Absolute size of all significant elements (upper and lower P4, M1 and M2) of the PU *Hystrix* sample are definitely larger (15–20%, cf. ROOK & SARDELLA 2005) than extant *Hystrix cristata*, as is generally true



Text-fig. 1. A–C: PU 104845 (Pirro Nord 10A), fragmentary right maxillary bone bearing M¹–M³. The specimen represents an old individual: the occlusal pattern in M¹ (only one enamel island left) corresponds to stage "H2" as defined by VAN WEERS (1990), both M² and M³ show the occurrence of 5 islands (no one fold remains), a pattern corresponding to wear stage "G7". A: lingual, B: labial, C: occlusal views. Scale bar represents 1 cm.



Text-fig. 2. PU 122743 (Pirro Nord 12), fragmentary right mandible bearing M_2 - M_3 . The second molar, although slightly damaged in its distal portion, can be assigned to stage wear "R" or "S", while the third molar, preserving one enamel fold both on lingual and labial side and three enamel islands, can be referred to wear stage "R" (VAN WEERS 1990). A: occlusal, B: lingual, C: labial views. Scale bar represents 1 cm.



Text-fig. 3. A-B: PU 122741 (Pirro Nord 12A), left M^{1-2} . The occlusal pattern is made up by the lingual fold and four enamel islands and thus corresponds to wear stage "F4" (VAN WEERS 1990). A: occlusal, B: distal views. C-D: PU 122765 (Pirro Nord 10E), right M^{1-2} . This tooth belongs to a young adult individual, the wear on the occlusal surface has not yet formed enamel islands (wear stage "B") and roots are still fully opened. C: occlusal, D: lingual, views. Scale bar represents 1 cm.

for the fossil species *Hystrix refossa*, while they are comparable in size to the Mio-Pliocene *Hystrix primigenia* and *Hystrix depereti* and to the Plio-Pleistocene species *Hystrix refossa*. Comparing the Crown Height / Occlusal Length ratio, the sample from recent collections available for this study confirms the hypsodontic status of the Pirro Nord Hystrix, with CH/L ratio values ranging above 1.0 (Table 1, cf. also figs 5 and 6 in ROOK & SARDELLA 2005). The only specimens with hypsodonty index below 1.0 are very old individuals with deeply abraded crown (and consequently very advanced wear stage: "F" for the M^3 PU122742, "T" for the M^1 PU122754) or a worn DP_4 (PU122753, Text-fig. 4C-D).

As already noted by VAN WEERS (1994), VAN WEERS & ROOK (2003) and discussed by ROOK & SARDELLA (2005), a distinctive trend in *Hystrix* evolution is the marked development of hypsodonty from the Mio-Pliocene species to the later Plio-Pleistocene and to the living ones.

Size and morphology of the studied material does not give evidence of the occurrence of the species *Hystrix (Acanthion) brachyura* at Pirro Nord. All the available specimens in fact fall into the size range of *Hystrix refossa*, and there is no evidence of the occurrence of a second (much smaller) *Hystrix* species.

Final Remarks

The study of the most recent recovered porcupine sample from Pirro Nord (collections housed in the Turin Palaeontological Museum) allows us to widen the known metrical variability of this *Hystrix* population, and to confirm our previous conclusions (ROOK

Table 1. Dental measurements (in millimetres) of the *Hystrix* sample from Pirro Nord housed in the Palaeontological Museum of the University of Turin, in site codes number refers to karst fissure, while letter (if present) to layer within fissure deposit (PAVIA et al. in press). Wear stage categories coding according to VAN WEERS (1990). L: Occlusal Length, B: Occlusal Breadth, CH: Height of the tooth Crown measured on the lingual side.

Collection	Number	Site	Element	Side	Wear stage	L	B	CH	CH/L ratio
PU	122774	10A	P ⁴	dx	E	10.60	9.20	19.80	1.87
PU	122763	10E	P ⁴	sx	B	11.95	13.50	24.25	2.03
PU	104845	10A	M ¹	dx	H	6.80	5.50	---	---
			M ²	dx	H	6.70	7.70	---	---
			M ³	dx	G	6.70	8.40	11.90	1.78
PU	122747	12	M ¹	sx	G	9.55	---	10.90	1.14
			M ²	sx	F	10.25	9.20	21.25	2.07
PU	105020	12A	M ¹⁻²	sx	F	9.35	9.25	17.60	1.88
PU	105022	12A	M ¹⁻²	sx	F	10.05	8.90	21.40	2.13
PU	122741	12A	M ¹⁻²	sx	F	10.85	9.50	19.40	1.79
PU	122773	10A	M ¹⁻²	dx	G	9.30	8.00	10.30	1.11
PU	122746	12	M ¹⁻²	sx	F	9.95	---	17.80	1.79
PU	122755	19	M ¹⁻²	dx	G	8.10	9.85	10.70	1.32
PU	122764	10E	M ¹⁻²	dx	F	9.50	9.00	20.50	2.16
PU	122765	10E	M ¹⁻²	dx	B	8.95	7.00	19.35	2.16
PU	106734	10E	M ¹⁻²	sx	F	9.70	7.95	17.00	1.75
PU	105021	12A	M ³	sx	E/F	8.90	7.30	19.30	2.17
PU	122756	19	M ³	dx	B	10.05	8.05	21.00	2.09
PU	122757	19	M ³	sx	G	9.40	8.20	11.00	1.17
PU	105083	10E	M ³	dx	F	9.80	7.90	19.80	2.02
PU	122742	10A	M ³	sx	F	7.65	6.75	6.85	0.90
PU	104488	10E	M ³	sx	G	9.75	9.20	17.65	1.81
PU	105039	10A	DP ₄	dx	O	10.00	7.50	11.00	1.10
PU	122753	19	DP ₄	dx	S	10.25	7.45	7.15	0.70
PU	122772	10A	P ₄	dx	S	11.90	8.80	17.50	1.47
PU	122743	12	M ₂	dx	R/S	---	---	---	---
			M ₃	dx	R	10.50	8.10	---	---
PU	122754	19	M ₁	sx	T	8.75	9.15	6.15	0.70
PU	122759	19	M ₁₋₂	sx	S	10.40	8.45	15.15	1.46
PU	122758	19	M ₃	dx	S	10.05	8.20	12.15	1.21
PU	122762	10E	M ₃	sx	O	9.85	8.25	14.55	1.48



Text-fig. 4. A–B: PU 122772 (Pirro Nord 10A), right P₄. This tooth, maintaining the enamel fold on the labial side and five enamel islands, can be referred to wear stage “S4” A: occlusal, B: labial views. C–D: PU 122753 (Pirro Nord 19), right DP₄. A: occlusal, B: labial views. Scale bar represents 1 cm.



Text-fig. 5. PU 105064 (Pirro Nord 20), Juvenile right femur with slightly damaged proximal end. A: anterior, B: medial, C: posterior, D: lateral views. Scale bar represents 5 cm.

& SARDELLA 2005). Final remarks of our study can be summarised under the following points:

- 1) The latest Pliocene – Early Pleistocene species of large hypodont porcupine in Europe is allocated to the species *Hystrix refossa* GÉRAVIS, 1852, a species characterised by dental dimensions larger than extant *Hystrix cristata* (comparable in size to the Mio-Pliocene species *Hystrix primigenia* and *Hystrix depereti*) and showing a degree of crown height (hypodonty) definitely higher than in all Mio-Pliocene *Hystrix* species.
- 2) *Hystrix refossa* is characterized by postcranial elements stoutly built and characterized by a relatively large size. The Turin sample

provides further evidence that the postcranial skeleton of this porcupine species was really larger and stouter, if compared to the late Miocene species *H. primigenia* and *H. depereti*, thus showing a different adaptation, perhaps linked to a dryer and/or cooler environment.

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